ENERGY

The Task Ahead

POLICY QUESTIONS AND ANSWERS

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Energy, Mines and Resources Canada
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FOREWORD

ENERGY is defined in dictionary terms as *the capacity for doing work.* In recent years, however, it has become an overworked word, synonymous with gasoline, heating oil, natural gas, uranium, electricity and coal. It has become most prominently imprinted in our minds in a context of crisis . . . the ENERGY CRISIS.

As Minister responsible for federal energy matters, I would like to be able to tell you that there is a solution to this crisis just around the corner. But I can't. What I can tell you is that the severity of the crisis can be diminished, but never reduced to the "good old days" of cheap fuels.

Canada's energy situation is one of our most complex economic facts of life. The fuels that contribute to the total energy picture are diverse. I believe that the complexity of the energy subject is the root cause of much misunderstanding and feel that it is my responsibility to provide as much information on the topic as possible.

In 1976, my department brought the complex factors of our energy prospects together in a publication called *An Energy Strategy for Canada — Policies for Self Reliance.* This book set nine major policy objectives. They were aimed at reducing Canada's dependence on foreign petroleum supplies as well as encouraging measures to bring greater security of supply in the total energy spectrum. Also included were five specific targets:

- to move domestic oil prices towards international levels, and to move domestic prices for natural gas to an appropriate competitive relationship with oil over the next 2-4 years;
- to reduce the average rate of growth of energy use in Canada, over the next ten years, to less than 3.5% per year;
- to reduce Canadian net dependence on imported oil in 1985 to one third of our total oil demands;
- to maintain self-reliance in natural gas until such time as northern resources can be brought to market under acceptable conditions;
- to double, at a minimum, exploration and development in the frontier areas of Canada over the next three years, under acceptable social and environmental conditions.

This set of objectives has raised many questions. For some questions, there are easy answers; for others, the answers are much more complicated. This booklet has been designed to share many of these questions and answers on the energy question with you. By learning more about the factors of the energy crisis you will be better able to adopt a more energy-conscious lifestyle.

Honourable Alastair Gillespie
Minister of Energy, Mines and Resources

CONTENTS

. . . The booklet attempts to give answers to these and other questions .....

What changes should we expect, and prepare for, in the coming decades?

In the past, inexpensive oil and gas have been available and Canadians have used large quantities wastefully. But world sources of oil are no longer cheap and we can't be sure how long the world will be able to draw plentiful oil from the ground.

As we look ahead, we can see, firstly, a new need to preserve and add to our own available stocks of oil and natural gas, and, secondly, a gradual shift away from oil and gas use toward other energy forms. Working toward these goals entails, among other things, higher prices for oil and gas.

Year-by-year, we'll have to count less and less on relatively easy-to-develop oil and gas, and more and more on expensive oil from our oil sands, heavy oil deposits, costly gas from fields in the far north and perhaps off the iceberg infested, East Coast. Finding and opening up these sources is already absorbing large sums of money.

Further ahead it is possible to see a time when oil and natural gas will have declined and other energy sources will be dominant. We won't throw off our old habits easily, but one way of encouraging this gradual but necessary shift is by allowing oil and natural gas prices to rise so that conservation is practised and other fuels, which haven't been competitive in the past, will become so.

Some consumers will not only make better use of gas and oil but may adapt to the use of other energy forms such as coal and nuclear-generated electricity and perhaps solar, wind and tidal power, and energy produced from wood or other vegetable or animal matter.

How would conservation help by 1985?

It would save all of us a great deal of money. It would also help us achieve at least partial energy security.

It has been clear for some years now that, as time goes on, the main oil producing areas of today are going to be able to supply less and less of what we demand. The country could slip into a high degree of costly dependence on foreign sources unless we can restrain our energy appetite and make the effort to develop oil sands and other energy sources of the future.

One important way the federal government is working to prevent over-dependence on foreign oil is by requiring that new cars obtain better mileage from each gallon of gas they use. This should have a major impact by 1985.

But we are already very big users of energy and, as our traditional oil sources decline, we will need to offset this by adding to our energy supply. We have a range of potential sources, but getting them ready for use won't be easy. Costs will be extremely high — and the more billions we spend (the total could go as high as $190 billion over the next 15 years) the harder it will be to find money for housing and other social needs.

- Arctic and other remote oil and gas resources could become available, but only at a far higher cost than our traditional supplies.
- Canada is a country favored with great water resources, but many of our most convenient hydro-electric power sites have been developed. Future expansion will be more costly.
- Oil can be pried from the bitumen of Alberta and power generated by burning Canadian uranium in reactors. But these developments require huge and growing capital investments.
- In the mountain valleys and under the plains of Western Canada, there are large deposits of coal. But it is costly to ship east for the use of the largest Canadian population centres, and the mining can be costly in environmental terms.

How much money Canada has to sink into development depends on the habits of each person, business, industry and government. The federal government believes we should not continue to add to our use of energy as in the past. If, as a nation, we are more careful, our need for new energy projects will be more moderate. Canada could avoid spending very large amounts between now and 1985 — the equivalent of many thousands of dollars for each family.

OIL AND NATURAL GAS

√ Regarding the price of oil and natural gas, what goal has the federal government set?

In many countries, oil prices have gone up step by step as world prices soared. Canada has been able to keep its crude oil prices among the lowest in the world. But the government believes that the economic price of such a policy will grow unless we move our prices toward the world level.

Crude oil prices in Canada remained almost $4 a barrel below the world price despite a 70-cent a barrel increase in the domestic price on January 1, 1977.

The first goal is to move crude oil prices toward the world price — though not necessarily all the way. The goal for natural gas is to move its price to the appropriate competitive relationship with rising oil product prices.

How do higher prices fit in with planning for the future?

A key national requirement is to make better use of all energy, not only oil and natural gas. All individuals can play a part in this. Everyone feels the impact of higher prices, but the thrifty user of energy can lessen the impact by making an effort to conserve energy. He helps himself and the nation, which seeks to hold down cash payments for imports of foreign oil.

Preparation for the future also means finding and developing new sources of oil and gas, and, equally important, fostering the development of energy sources which will gradually do more and more of the work now done by oil and gas. As oil and gas prices rise, other forms of energy, which haven't been able to compete in the past, may become more attractive.

Assuring a future supply of oil and natural gas depends on exploration. How much exploration is taking place?

Exploration has increased substantially after a slowdown following the sharp changes in international oil prices.

At first, tax and other payments were increased as provincial governments sought to assure they would receive what they considered fair shares of revenue from higher-priced oil and natural gas. But provincial and federal governments have since reviewed their earlier measures and introduced tax and other changes to allow a greater share of revenues to producers in return for a renewal of investment in petroleum exploration and development.

In combination, the federal and provincial tax changes have brought about an improved climate for exploration investment. Since they came into effect in late 1974 and 1975, an increasing volume of investment dollars has been attracted into exploration, with activity being particularly heavy in Alberta. One important consequence has been to establish the existence of enough natural gas to replace the gas currently being used up by consumers and industry.

It is estimated that an adequate exploration and development effort will require annual expendi-

tures of more than $2 billion, in 1975 dollars, for the next five years.

If development is to take place in the Arctic and other frontier areas, market prices will have to be high enough to make very expensive delivery systems from these remote areas economically viable. As long as prices remain below such levels, it is not easy to generate investor enthusiasm.

Nevertheless, it is the aim of the federal government to encourage greatly increased activity in the Arctic and other frontier areas, both by direct investment through federally-financed agencies and by private investment.

Altered regulations for federal lands will provide flexible royalties, so that, where a producing area is not highly profitable, the federally-imposed royalty will be nominal. The regulations will also provide for participation by Petro-Canada, the national oil company.

How oil prices have risen

The table compares the price of Canadian oil delivered to Toronto with the price of foreign oil imported into Eastern Canada. Eastern consumers do not pay the full import price because of the federal financial assistance.

	Imported crude at Montreal	Canadian crude at Toronto
1970 (June)	2.60	3.30
1976 (June)	13.00	8.50
1977 (January)	14.10	10.30

NOTE: Assumes the Canadian and U.S. dollars at par.

How does the federal government actually keep prices below the world level in Canada?

A top federal priority has been to hold the price of heating oil and other oil products below the rapidly escalating world price. Oil imported into Canada is purchased at the world price, but part of the cost is assumed by the federal government, which collects money for this and other purposes from a charge on Canadian oil exports and from the 10-cent per gallon tax on gasoline used for non-business purposes.

Between 1974 and 1976, roughly $3.7 billion was channelled this way to consumers of imported oil in B.C., eastern Ontario, Quebec and the Atlantic provinces.

With our traditional sources of oil declining, it also made sense to cut back on oil exports and to use more of our remaining oil in Canada. With federal backing, our main oil pipeline was extended so that Alberta oil could be supplied to Montreal refineries.

How did consumers benefit from oil import compensation payments during the last three years?

The total amount paid from the start of the program in 1974 to the end of 1976 is estimated at $3,705 million. Benefits by province, based on the amount of crude oil consumed in those provinces, are estimated as follows:

	Aggregate ($ Million)	Estimated per Capita (Dollars)
Newfoundland:	$210	$383
Nova Scotia:	425	521
P.E.I.:	51	433
New Brunswick:	326	488
Quebec:	2,196	257
Ontario:	475	59
Manitoba:	3	4
B.C.:	17	7
N.W.T.:	1	38

Where oil needs are largely met by western Canadian supplies at the established Canadian price, the amount of compensation is relatively small.

What has the single price policy meant for oil prices across the country?

The retail prices paid by consumers vary somewhat from region to region because of local market conditions. But, at the wholesale level, fuel oil and gasoline (excluding temporary voluntary allowances) have been selling at similar prices across the country. (Temporary voluntary allowances — pump price support — are provided by the supplying oil company, at the station operator's request. They effectively reduce the dealer's wholesale price, in order to provide him with a reasonable margin when market conditions depress pump prices.)

Here are sample prices for early 1977 (they have changed since) in cents per imperial gallon.

	Wholesale	Retail
HALIFAX		
gasoline[1] (regular)	80.6	91.4
heating oil[2] (furnace)	35.0	45.3
TORONTO		
gasoline[1]	81.0	81.2
heating oil[2]	34.5	46.9
VANCOUVER		
gasoline[1]	77.2	79.4
heating oil[2]	37.0	46.5

NOTES:
(1) Wholesale gasoline price is the posted dealer tank wagon price and includes (a) federal sales tax (4.3¢; (b) excise tax (10.0¢) and (c) provincial road tax (21.0¢) — N.S.; 19.0¢ — Ont.; 17.0¢ — B.C.). Retail gasoline price is the weighted average pump price for most service stations in a city.
(2) Wholesale heating oil price is the average price paid by furnace oil distributors.

How do Canadian gasoline prices compare with prices paid by motorists in other parts of the world?

Prices at the pump vary in different Canadian cities. An average price for a Canadian gallon of regular gasoline in Ottawa in December 1976 was 82 cents. Of this, about 33 cents were for taxes. Average prices for the same quantity in some other countries, as of mid-1976, are shown below. Per gallon taxes are shown in brackets.

Britain:	$1.40	(.71)
U.S.A.:	$ .69	(.14)
West Germany:	$1.57	(.91)
Japan:	$1.59	(.64)

How is the price of a gallon of gasoline at the pump in a gas station made up?

The breakdown of the price a motorist pays can be seen from the following example which is based on early 1977 prices at service stations in Ottawa. As can be seen there is a price range of from 82 to 94 cents per gallon, which may be considered typical of conditions in the urban markets of Ontario and Quebec. All figures have been rounded to the nearest cent.

The retail price and breakdown in Atlantic Canada and in the west would be different due to varying provincial taxes, different transportation and marketing costs and the use of different types of crude oil.

	A Full Pump Price Assuming Normal Margins	B Lower Pump Price
Payment to oil producing country*	33	33
Crude Supplier's margin	1	1
Freight	2	2
Sub-total	36	36
Less federal compensation	10	10
*COST TO REFINERY**	26	26
Plus:		
Refining cost	5	5
Refining margin	2(1)	—
COST LEAVING REFINERY	33	31
Plus:		
Marketing Cost	9	9
Transportation	2	2
Wholesale margin	6(2)	—
Federal sales & excise tax	14	14
Provincial road tax	19	19
COST TO RETAILER	83	75
OTTAWA PUMP PRICE	94¢/gal.	82¢/gal.
Difference between cost to retailer and pump price (3)	11	7

*Prior to OPEC price increase of January 1, 1977

(1) Includes allowance for depreciation and other indirect costs.

(2) Includes allowance for income taxes and profit.

(3) If not already recovered (column B) this difference must account for:
— refinery margin
— wholesale margin
— retail margin (a guaranteed minimum of about 7¢/gal.)
— income taxes.

How dependent are we in Canada on oil and natural gas as sources of energy?

In the cold Canadian climate, oil and natural gas have played an absolutely vital role, and they will continue to be vital for many years. Increasingly, we will be making use of our coal and uranium and other energy resources, but the fact remains that our present way of life derives about 65 per cent of its energy from oil and natural gas. They are the prime heating fuels and oil products and, of course, are the key to most transportation.

What is the oil import situation now?

As heavy users of oil, Canadians must either have a steady flow from Canadian oilfields or buy oil from abroad. The amount of oil we can draw from our oilfields is dropping. Attempts are being made to open up new sources of supply but we are facing a number of years when our oil requirements will far outdistance what we can produce. Efforts in recent years have been aimed at supplying as big a share of our needs as possible from our own sources. A few years ago, a significant portion of Western Canada oil was sold in the U.S. market, but now exports are a small fraction of total production and Alberta oil is sold in Canada as far east as Montreal, which has traditionally been able to draw on cheap (but now expensive) foreign imports.

Greater use of western oil in the eastern market has kept imports from soaring for the time being, but in the years ahead we could easily find ourselves buying larger and larger quantities of oil abroad to meet rising demand. A key government aim is to limit the amount of oil Canada must import through increased exploration and development in Canada and a strong conservation program.

Why does the federal government consider it so important to limit the amount of oil we import?

The whole international oil supply picture has changed drastically during the 1970s. Foreign oil-producing nations are co-operating in a way they never did previously to assure prices remain high. Conceivably, major foreign producers might once again reduce their production and embargo certain consuming countries in pursuit of political aims.

And, if the import needs of major industrial countries continue to grow, at some point in the 1980s the total need may exceed what key oil-producing nations are willing to make available.

Already, we have had to absorb enormous price increases. *Every barrel of crude oil we import in 1977 will cost almost six times as much as the same barrel would have in 1972.*

And the hard fact is we are dependent on foreign producers in a way we haven't been previously. We haven't got big enough reserves to allow us realistically to pump enough of our own oil to eliminate imports. So we have to make heavy payments for foreign oil, and less oil is being exported to help cover the cost.

For 1977, this could mean an outflow of nearly $1.2 billion, an increase of more than $650 million over 1976 net payments for imported oil. As we become more dependent, the outflow will increase.

What was the impact financially of Canada's oil imports in 1976? How did earnings from sales of natural gas fit in?

Canada used more of its own oil in 1976 than previously, by cutting back on exports to the U.S. That was some help but what we had to pay out exceeded our oil earnings by about $500 million, and the trend indicates an increasing dollar outflow in years to come.

The natural gas we export to the U.S. has brought us greatly increased earnings because of rising prices. Earnings for 1976 are estimated at nearly $1.6 billion. These earnings are a big plus for Canada.

Import costs and export earnings

As the table shows, the cost to the nation for importing oil (after deducting earnings from oil exports) has risen and could become extremely high by 1985. Bracketed figures indicate payments for oil purchases. Natural gas figures indicate earnings on sales of Canadian natural gas to foreign buyers. Federal conservation and other policies are aimed at holding oil import costs in 1985 below the level indicated here.

	1970	1976	1985 (estimated)
	$ millions		
OIL (crude and products)	50	(600)	(8,500)
NATURAL GAS	200	1,575	2,950

NOTE:
Figures calculated on CIF basis.
Estimate for 1985 assumes that international oil prices escalate a 7 per cent annually and that Canadian gas export prices escalate at the same rate. Net oil imports for 1985 estimated at 950,000 barrels daily and gas exports at the level licensed by the NEB as of 1976.

How much oil does Canada import, and from where?
How much oil and natural gas do we export?

In 1976, 248 million barrels of crude and oil products were imported, most of it through a pipeline between the Atlantic coast at Portland Maine and Montreal. About 38 per cent of our imports came from Venezuela, 24 per cent from Iran, 16 per cent from Saudi Arabia and 22 per cent from other sources.

In 1975, we exported about 310 million barrels of oil and in 1976, about 233 million barrels. In 1977, we will export an estimated 150 million barrels.

As less oil goes to exports, more flows to Eastern Canada through a pipeline system recently extended from Sarnia to Montreal. Construction of this extension was encouraged by the federal government. With more Canadian oil being used in Canada, import requirements in 1977 may be held to about 200 million barrels.

In 1977, Canada will export roughly 1 trillion cubic feet of natural gas, roughly 40 per cent of our production.

Why couldn't we have kept our oil and natural gas prices lower?

The government has looked very carefully at what it would have meant to stand pat with 1975 oil and natural gas prices. If prices are held back too much, people and industry are more likely to keep up a high rate of oil and gas use. We would use up readily-available Canadian sources of oil and natural gas more quickly. We need to stretch out our oil while building up a new supply base.

Our future sources of oil and gas will take time to open up and the cost will be very high. How high has been shown by the Athabasca oil sands, where even the 1976 international oil price can't be counted on to bring about large-scale development of the kind Canada will need.

Government studies show that, by 1985, keeping prices low would have resulted in a wide gap between our total energy need and what we could get from our own oilfields, hydro dams and other sources. Major new sources of supply would not have been developed. And, with a big share of our oil imported, much oil would have been sold in the Canadian marketplace far below the purchase price, and how to finance the loss would be a severe problem for Canada. Industry would have to adapt quickly to the international price rather than the gradual rate inherent in our national policy.

What assurance does the public have that higher oil and gas revenues aren't skimmed off, and are actually used for exploration?

Since consumers now pay a great deal more for oil and natural gas, it is important that governments and industry co-operate to keep adequate amounts of money flowing into exploration.

By the use of taxing incentives, the federal government is trying to assure that it contributes to the exploration effort in all parts of the country. In 1975, the government indicated it is prepared to accept a decreasing share of oil and natural gas revenues, and to allow the industry a correspondingly larger share, in cases where the industry spends the added revenue on exploration.

Between 1976 and 1980, it is estimated that, as prices increase, the petroleum industry on average will retain about 40 per cent of production profits — part of which will go into exploration. A 17 per cent share will go to the federal government and a 43 per cent share, on average, to the governments of the producing provinces that own the oil.

In cases where the oil and gas well is long-established and costs comparatively low, the basic profit share claimed by governments would be higher than average. Where the producer faces higher costs, tax adjustments make allowance for this.

The flexibility of taxes and royalties is of special importance in determining who gets what portion of an additional dollar as prices rise. If the producer is not using his share of the new revenue for exploration, the federal government claims 27 per cent of the profit on the dollar, the industry receives about 25 per cent, with the remainder going to the province. However, if the producer puts 50 cents of the dollar into exploration, federal taxes will claim only three per cent and the provincial share will also be reduced.

Higher oil prices also mean rising costs. How serious is this?

The government has calculated that an increase of $1 per barrel of crude oil might add 0.7 per cent to the Consumer Price Index over a 12-month period. With some cutting back of energy use, however, the impact could be less.

Government policies have provided protection for consumers but the government exempted crude oil and natural gas prices from the 1975 anti-inflation program. This was done as part of the effort to promote thriftier use of diminishing oil and to encourage new energy sources.

The government, however, is conscious of the need to avoid excessive costs to parts of our industry, which depend heavily on energy and must compete with larger industry in the United States. This can mean judging our price increases partly on the average oil price in the United States, which has continued somewhat below the world price. This is a factor in limiting Canadian prices for industrial users of both oil and natural gas.

What plans has the government to cope with an oil embargo in the future?

Western oil can now move as far east as Montreal through an extension of the Interprovincial Pipeline's system. In an emergency, more of Canada's requirements than in the past could be met from our own resources.

Canada is a member of the International Energy Agency which provides for the sharing of oil supplies in the event of an emergency shortage. The sharing plan requires participating countries to have a program for restraining oil demand in an emergency and to establish emergency reserves.

Have we been finding as much new oil as we once thought we would?

There was great optimism about our undiscovered resources in the late sixties and early seventies, though little actual exploration had been done outside Western Canada. Subsequent experience has dampened that optimism regarding frontier supplies.

The failure to discover readily-useable sources in completely new oilfields is an extreme disappointment. But several "second best" possibilities remain.

One is a major future oil strike in one of the frontier areas. If such a strike were big enough, the oil might be economically attractive despite the high cost of development and transportation.

Other high-cost sources such as the heavy oils of Western Canada warrant more attention and are getting it.

Another important point is that a higher return to oil producers stimulates a search for more production from known reservoir areas, both by conventional methods and by use of sophisticated recovery technology which may become economic as a result of further research.

Where will future supplies of oil come from?

As the amount of oil available in our primary oilfields declines, we will have to look to other locations for Canadian oil. There are several possibilities, none of them easy or cheap to develop.

Small-scale production of what is known as heavy oil could be expanded in Alberta and especially around Lloydminster, Saskatchewan. It has disadvantages which in the past have kept it to a minor role, but under new conditions production might be greatly enlarged.

The oil-bearing formations at Cold Lake, Alberta and the Athabasca and other Alberta oil sands contain very large quantities of oil. As yet, the difficulties which have kept them from becoming a major source of oil have not been overcome. Production will increase, but it will probably be 1985 at the earliest before they fill a substantial part of Canada's oil requirements.

Exploration also is taking place in a number of areas outside Western Canada, including the Mackenzie-Delta-Beaufort Sea, the Sverdrup Basin in the northern Arctic Islands and the Labrador Shelf. Significant deposits have not yet been found. Exploring and developing these areas will be slow, difficult and expensive. Therefore, it is unlikely that frontier oil in quantity will be available before the late 1980s.

The goal of providing two-thirds of our oil requirements from Canadian sources will require greatly expanded production from these various sources as well as better conservation by all Canadians. With a sufficient effort by 1990, we could have up to 1 million barrels a day of production coming from our oil sands and heavy oil resources — more than one half of total Canadian production.

What is meant by 'heavy oil'?

Light crude oil flows readily and often may be drawn out of the ground without difficulty. Heavier oils are those which, because of their thickness, flow less readily. They are more difficult to get out of the ground. Because of these characteristics Lloydminster-type oil is at a considerable disadvantage compared to light Alberta crude. Only a small fraction of the oil in the Lloydminster deposits has been extracted in the past, and this has always required special recovery techniques.

The even heavier oil in the Cold Lake, Alberta area has so far been virtually untapped because of the difficulty of getting it out of the ground. It is in a form resembling molasses contained in sandstone and any development requires that

its flowing qualities be improved underground. Methods of doing this have been tested but the cost remains high.

The oil occurring in the Athabasca and related sands is referred to as bitumen rather than heavy oil because it is actually an asphalt-like solid at normal temperatures. A part of the resource is near the surface, but most of it would have to be drawn from underground and the problems presented would be like those encountered at Cold Lake, but in a more extreme form.

It isn't yet clear whether the underground deposits will become accessible through the application of known methods of extraction, such as those which may be feasible at Cold Lake and in the Lloydminster area.

The natural 'flowability' of the heavy oil deposits mentioned is a point of difference from the Athabasca bitumen, but in many respects the three resource groupings are similar. As they occur naturally, they require several stages of treatment or upgrading, first, to make them transportable through oil-carrying facilities, and second to remove sulphur and otherwise make them suitable to be fed into regular refineries, for the production of gasoline, heating oil and other products.

At the higher oil price level that has now been attained, expanded recovery of Lloydminster-type oil may be financially attractive immediately. The necessary upgrading facilities are not yet available in Canada but the development of such facilities is now a real possibility. Production of 100,000 barrels a day could occur by the early 1980s.

How large are the various heavy oil and oil sands deposits?

Compared to the gigantic amount of bitumen contained in the Athabasca and related sands, the Lloydminster deposit is modest. Even so, it represents a known source where production can be increased within the next decade. Between 1.5 and 4.5 billion barrels of good-quality oil may be obtainable eventually and the actual amount in the ground may exceed 18 billion barrels. Even three billion barrels recovery would be the equivalent of more than one-third of the oil already produced in Western Canada.

The sands in the area of Cold Lake, Alberta contain very large amounts of heavy oil which can be made to flow somewhat more easily than the Athabasca deposits. But development at Cold Lake will be by means of wells and such wells have as yet only been operated experimentally.

Eventually, as much as 30 billion barrels of synthetic crude oil may be recovered from the Cold Lake sands, which may contain as much as 165 billion barrels in the raw form.

The Athabasca bitumen deposits are near enough to the surface in some places to enable strip mining, and that is the technique now in use.

The restraining factor in future surface development is economic — in principle as much as 27 billion barrels of synthetic crude oil could be obtained by mining. Other methods will be necessary to get at the deeper deposits, which takes in the greatest portion of the resource.

All told, there may be as much as 800 billion barrels of bitumen in the Athabasca-type sands, or nearly double the amount of oil in the Middle East. Eventually between 70 and 170 billion barrels of synthetic crude oil may be obtainable.
But most of the Athabasca potential will remain untapped until experimental methods are ready for widespread use. That may not happen until the 1990s.

What the public hears now about our oil and gas resource potential sounds a lot different from what it heard in the early 1970s. What actually is meant by potential?

In any discussion of oil and natural gas for the future, an essential difference should be kept in view.

Year-by-year, knowledge of an established producing area such as that of Western Canada increases and this knowledge goes into a calculation of our *RESERVES* — that is, oil and gas *known to exist* and which can be delivered to consumers. As gas or oil is drawn out of the reservoirs each year, enough progress may be made in locating further amounts in the area to keep the reserve constant or expanding. But if replacement fuel is not located the reserve will decline.

These reserve figures are quite different from estimates of the nation's total quantity of oil and gas, including what *may exist* in frontier areas such as the Western Arctic or the Arctic Islands. Such estimates of *RESOURCE POTENTIAL* do not attempt to tell how much the country can count on, only what might be expected to occur, judging by geological information and whatever exploratory drilling has taken place.

Estimates made on the basis of an optimistic reading of the geology may have to be tempered if the results of further exploratory drilling are not encouraging. This is what has happened in Canada in the first half of the seventies.

In preparing 1976 estimates, geologists used a technique involving a range of estimates of resource potential. The approach was cautious. The 1976 estimates did not discount the possibility of very large amounts of oil and gas occurring in Canada; however, the probability of this being the case was viewed as low rather than high.

Whereas earlier estimates had included the continental slope and rise off Canada's coasts, the 1976 estimate does not. Leaving out these inaccessible areas resulted in about a one-third reduction in estimated potential resources.

How much oil was available in 1976 from our traditional sources in Western Canada?

For the past several years, the amount of new oil discovered has not been nearly adequate to replace what we have produced annually. Our reserves of easily accessible oil are thus on the decline, even though we have sharply reduced our exports. As of the end of 1975, we had a total of 8 billion barrels of such oil and other liquids.

To stop the erosion of these reserves in the next few years, we would have to be able to tap completely new oil pools, as well as making available additional quantities of oil from known fields. There has been little success in finding such new pools. In 1975, for instance, the amount of oil discovered outside known oilfields would meet Canada's requirements for just one day.

Though Canadians have become a bit more careful about how we use oil we are still using as much yearly as we ever have. Total 1975 production was 650 million barrels.

The 1975 rate of use meant that, during that year, we reduced our stock of readily-available oil by about eight per cent. Production in 1976 was an estimated 590 million barrels. A key test for the coming years will be whether we can stretch out the remaining oil, especially by better conservation.

The reserves referred to here do not include oil in the Athabasca and other oil sands which, except for a minor amount, were not available for production. Only a small quantity of oil has been discovered in areas outside Western Canada.

√ **What is the oil picture likely to be in 1985?**

By that time, the supply of Canadian oil could fall seriously short of what we will be using. If our conservation efforts were to prove ineffective, our total oil requirements could be one-third higher by then.

A policy which did not strive to increase our oil supply and conserve could mean that, by 1985, we would become dependent on foreign oil imports for 40% or more of our oil demand.

If, for instance, we imported 950,000 barrels a day, our dependence would be four times what it was at the end of 1976 because we will have no exports to balance off our imports. As much as $8.5 billion could flow overseas in 1985 alone.

With its various special programs, the government is attempting to reduce this dependence to no more than one-third or, to put it another way, to ensure that our own resources meet at least two-thirds of our oil requirements.

Some of the demand might be shifted to natural gas or electricity, but if the goal is to be achieved new oil will have to be made available, either from frontier areas or, as seems more likely, from the Western Canada deposits of heavy oil and from growth of oil sands production, though this may be slow.

While many of today's oilfields will be in decline, production from the Lloydminster and similar heavy oilfields should increase sharply in response to higher oil prices.

As of 1976 what was the federal estimate of Canada's undiscovered oil resources of the type that have mainly been produced in the past in areas like Alberta?

Finding a major deposit of readily-useable oil in the undeveloped northern and east coast areas has been the constant hope, but so far it hasn't been realized.

Exploration ventures are launched on the basis of promising geological conditions. From these same conditions, estimates can be made of the possibility of oil occurring but there can be nothing certain until prospects have actually been drilled.

In recent estimates, the federal government has indicated what our undiscovered resource might be at high, medium and low probability. An estimate based on data up to 1976 suggested a high (90 per cent) probability that 16 billion barrels of oil remain to be discovered, a 50 per cent probability that 22 billion barrels remain undiscovered, and a low (10 per cent) probability that 34 billion additional barrels might ultimately be found.

The oil sands of Alberta are not included in this estimate. However, it does cover the Lloydminster-type heavy oils of Alberta and Saskatchewan.

By comparison, in 1973, the federal government estimated there might be as much as 83 billion barrels of oil remaining to be discovered. Interim drilling results have been very disappointing. Another important point is that the 1973 estimate took in large inaccessible areas off Canada's coast which were excluded from the 1976 assessment.

Where have we been seeking natural gas for the future and what are the prospects?

A successful effort has been made to identify gas at deeper levels and in peripheral areas in Western Canada. The higher prices being received by producers are resulting in vitally important additions to reserves.

In the north, major discoveries have been made despite very high exploration costs. Some gas has been located in the Mackenzie Delta — Beaufort Sea area. Large amounts of natural gas are known to exist in and around the Arctic Islands.

Off the east coast of Canada, there are indications of gas in several locations, including Sable Island and the Labrador Shelf. More exploration will be necessary to see how great gas volumes are in each area and to determine whether and when they could be made available to consumers.

Bringing northern resources to market will involve very costly new transportation systems. The Labrador Shelf exploration area would pose severe development difficulties even if large volumes of gas are discovered. Because of water depths, marauding icebergs and pack-ice, it is unlikely the necessary technology would be available before the 1990s.

While the amounts of frontier gas found to date do not appear sufficient to be economically developed at present, the signs to date have been reasonably encouraging where natural gas is concerned.

What was the natural gas picture as of 1976?

As of the end of 1975, the Canadian natural gas reserve was 59 trillion cubic feet. Combined export and domestic requirements in 1975 were 2.5 tcf for the year, and in 1976 and 1977 were expected to be roughly the same. More than enough new gas from Western Canada was added to the reserve during the year to cover the amount drawn out of the reserve.

The reserve includes only available gas, and thus does not include gas known to exist in the Mackenzie Delta and the Arctic Islands. Approximately 25 tcf of gas has been discovered in frontier areas,

which are not as yet serviced by pipeline or other delivery systems.

While as much gas is being found in Western Canada as is required annually, it is believed that somewhere between 50 and 75 per cent of the economic gas in the area has already been discovered, hence the importance of opening up new frontier sources.

What is the natural gas picture likely to be in 1985?

Between now and 1985, readily deliverable supplies of gas from Western Canada appear to be adequate to cover fully potential Canadian needs and the amounts contracted for export to the United States. During the next decade, increasing prices obtained for gas should encourage additions to Western Canada reserves and further discoveries in the frontier.

Once connected to markets, the Arctic gas would become part of the reserves, and would help maintain the supply of gas beyond the mid-1980s.

The Canadian government has estimated that, even at higher prices, Canadians might require 2.3 trillion cubic feet of gas, and be using half again as much as in 1976. In addition, annual exports of almost 1 tcf are specified under existing export contracts through the late 1980s.

The total 1985 requirement could be supplied with some gas to spare if Arctic deposits are connected to market. But forging such a link will be extremely costly and difficult particularly in the case of gas located offshore in the Beaufort Sea and the Arctic Islands.

As of 1976, what are the federal estimates of future natural gas resources?

On the basis of promising geological data, substantial exploration has taken place in areas other than Western Canada, and a considerable quantity of gas has been found.

In recent estimates, the federal government has indicated what our resource potential might be at high, medium and low probability. The following figures refer mainly to undiscovered gas, but include gas known to exist in the frontier regions which is currently out of reach of consumers.

Data available in 1976 suggested a high (90 per cent) probability of gas potential of 170 trillion cubic feet, 50 per cent probability of 218 tcf, and low (10 per cent) probability of gas potential of 319 tcf.

By comparison, in 1973, the federal goverment estimated there might be more than 700 trillion cubic feet remaining to be discovered, but this included estimates in inaccessible areas off Canada's coast which were excluded from the 1976 estimates.

What are some of the oil and natural gas exploration and development ventures the federal government and affiliated agencies are supporting?

Much of the initiative for exploration in the Arctic Islands has come from Panarctic Oils Ltd., in which the federal government is the major participant. This difficult and costly exploration effort has been a success story which has resulted in the location of very large quantities of natural gas and some oil.

In 1975-76, Panarctic spent $45 million on the northern operation and was to spend $70 million during 1976-77. Under a four-year exploration agreement, a group of oil companies including Petro-Canada will give financial backing to Panarctic's effort to try to find enough additional natural gas and oil in the islands and in adjoining waters to justify major expenditures on systems to connect the resources to southern markets.

Production from the hard-to-handle Alberta oil sands will increase substantially once the Syncrude of Canada Ltd. processing plant comes into operation, probably in mid-1978.

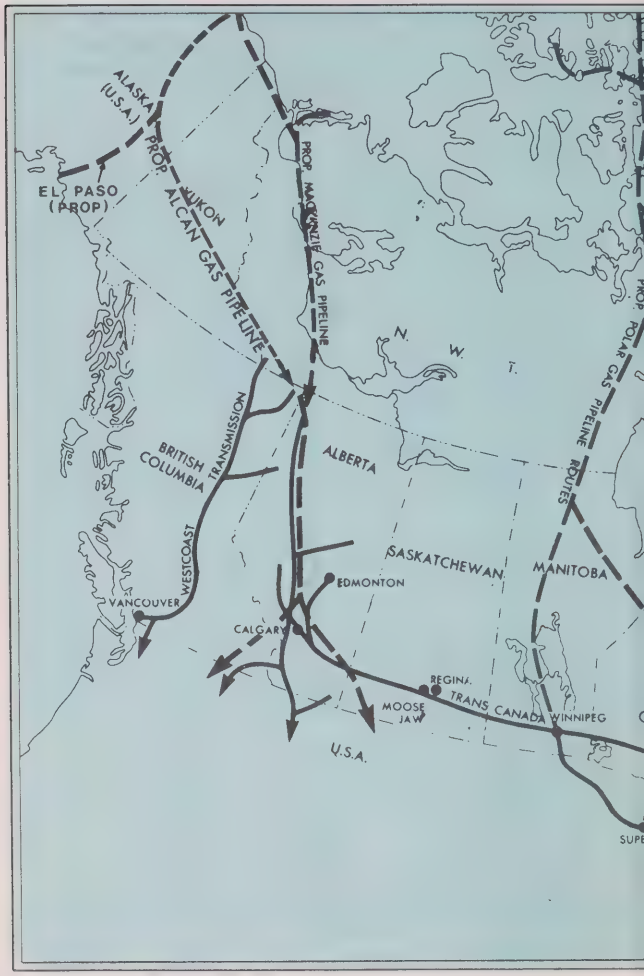
Through the actions of the federal government and the governments of Alberta and Ontario, preparation of this $2½ billion project was able to continue despite the withdrawal of a key private participant. The federal government invested $300 million directly, and also guaranteed that Syncrude oil would be sold at world market prices — higher than the price other oil commands in the domestic market.

The Syncrude plant will eventually have a daily output of 125,000 barrels and construction of a second Syncrude-type plant, which would push production up considerably further, is a distinct possibility.

The federal government, in co-operation with the governments of Alberta and Saskatchewan, is supporting research into development and refining of the heavy oil resources of the two provinces.

Extensive frontier exploration is also being supported by the federally financed oil company, Petro-Canada.

Eastern activity to date has included $20 million worth of drilling by Petro-Canada on the Scotian Shelf, southeast of Halifax, and off Cape Breton.


ALASKA (U.S.A.)
PROP. YUKON ALCAN GAS PIPELINE
EL PASO (PROP)
PROP. MACKENZIE GAS PIPELINE
N. W. T.
PROP. ARCTIC GAS PIPELINE ROUTES
BRITISH COLUMBIA
TRANSMISSION
ALBERTA
WESTCOAST
SASKATCHEWAN
MANITOBA
EDMONTON
VANCOUVER
CALGARY
REGINA
TRANS CANADA
WINNIPEG
MOOSE JAW
U.S.A.

GAS PIPELINES IN CANADA

Additional drilling along the Scotian Shelf, and off the Labrador Coast is scheduled and, further in the future, Petro-Canada will take part in exploration at extreme water depths. Activity is also to continue around Sable Island. Petro-Canada has been provided with debt and equity funding of $1.5 billion.

What has the federal government done to make sure the impact of northern pipelines is properly assessed?

Because of the far-reaching implications of pipeline development for Canada's northern areas and native peoples, the government in 1974 set up the Mackenzie Valley Pipeline Inquiry commission headed by Mr. Justice Thomas Berger. This resulted in almost two years of the most searching hearings on such a subject ever undertaken in Canada, with sessions in remote communities all across the north as well as in centres in southern Canada.

Proposals for natural gas pipelines from the Mackenzie Delta to southern markets have been considered at extensive National Energy Board Hearings, covering all national interest matters.

Potential impact of pipeline development on social, environmental and economic conditions has been studied for several years by an interdepartmental task force with an expenditure of close to $20 million. By these means, the government has built up a storehouse of information necessary for making decisions on the future of the north.

CONSERVATION

Where can the greatest amounts of energy be saved through conservation methods?

Through conservation, it is possible to reduce the growth rate of energy use in each of the major sectors.

In the cold Canadian climate 30 per cent of our energy goes toward space heating of buildings. But a greater effort to keep the heat in both residential and commercial buildings through improving the old and better designing the new is economically justified and could cut significantly our growth in energy use.

Automobiles too are a prime target because they consume about 15 per cent of our total energy

budget and because there is room for considerable improvement in fuel economy.

Industry is also a major energy consumer and, between taking advantage of government incentives and working out programs with energy conservation goals, this sector could play a major role in cutting back our energy demand.

The following list shows where our energy goes:

	Percentage of Total Energy Consumption
A — Automobiles	15
B — Buildings (Residential, commercial and industrial use for space and water heating and lighting)	30
C — Appliances (not including heating)	8
D — Industry	30
E — Federal Government	2
F — Other areas including public transportation	15
	100

The 1976 review by the International Energy Agency (IEA) showed that Canada was behind many other nations in energy conservation. Why?

Canada and the U.S. are each well ahead of the rest of the world in energy consumption. Based on figures compiled by the IEA for 1975, Canadian energy consumption per capita is about twice as high as that of many industrialized countries, including West Germany and the United Kingdom, more than three times that of Japan, and one and a half times that of Sweden.

There are several reasons for Canada's record, most notably our historically low energy prices, relative to most other countries. Owing to our domestic production of oil, we were not so severely hit as other nations by the international oil price crisis of 1973. The result was a relative lack of concern by Canadians.

Canadians working in energy conservation also face a greater challenge than do their counterparts in some other countries since, in Canada, energy conservation falls within both federal and provincial jurisdictions. In addition Canadian distances are greater and the climate colder than in many other IEA nations, both necessitating energy use.

Which uses of energy have been growing fastest?

The changes between 1960 and 1974 are shown in the table below.

Growth of energy demand was greatest in the commercial sector — heating, cooling, and lighting of office and retail buildings. Industry, particularly the energy supply industries, showed the next fastest growth, followed by transportation (air in particular) and residential buildings.

CANADIAN ENERGY CONSUMPTION
in British Thermal Units (10^{12})

	1960	1970	1974
	BTU	BTU	BTU
Domestic and Farm	714	1,036	1,176
Commercial	247	701	768
Industrial	1,001	1,600	2,004
Transportation	746	1,209	1,518
Energy Supply	212	425	471
Total BTU's (10^{12})	2,920	4,971	5,937

(This is energy finally consumed by the user and does not include energy lost in converting fossil fuels to electricity in thermal electrical plants.)

Total energy demand grew by 5.5% (about 350×10^{12} BTUs) in 1974. In 1975, there was almost no growth. Conservation efforts contributed to this, but other important factors were the generally poor economic situation and weather conditions.

What can be done to save on home heating bills?

Heating and cooling Canada's homes takes up 15 per cent of our total (almost 50 per cent of our personal) energy consumption, and individual residences have an important share in this.

Such publications as "100 Ways to Save Energy," "Keeping the Heat In," and "The Billpayer's Guide to Furnace Servicing" provide many dollar-saving do-it-yourself ideas.*

Reinsulation, weatherstripping, caulking and the like can cut heat loss by an average of 40 per cent. These savings on heat will return the average investment of $880 in less than five years. Even simple tricks like turning down the thermostat at night (to 18°C, or 65°F) or when the family is away, or closing the drapes at night, can help.

*These publications are available from the Office of Energy Conservation, Ottawa K1A 0E4.

As insulation is an item of special concern, the federal government and some provincial governments have dropped the sales tax on insulation as an incentive to refit existing homes. The federal government has begun a computer audit program in Prince Edward Island and Newfoundland called Enersave through which householders can get a computerized analysis of their insulation needs, initial costs and savings by simply filling out a questionnaire. This program, if successful, will be applied to other areas of Canada in 1977.

What are some of the indirect ways the householder can help conserve energy?

Controlled use of "throw-away" items or replacing these by returnables can reduce energy consumption at the point of manufacture. So can refusing a bag for groceries, avoiding extra wrappings for purchased items, and recycling such things as paper, bottles, and tin products rather than simply throwing them out.

What specifically is being done to improve buildings?

The federal government has prepared guidelines for the design and construction of energy efficient buildings and has proposed them for adoption as a supplement to The National Building Code.

The federal excise tax has been removed from insulation materials and from certain types of energy conserving equipment. Loan and grant programs for improving existing residences are being modified to reflect the need to improve insulation.

Results of energy conservation attempts in building can be quite startling. Carleton University in Ottawa, for instance, saved $64,000 a year by removing 12,000 lighting tubes while still maintaining adequate lighting levels. The university has saved even more by modifying operation procedures related to heating, ventilation and air conditioning systems. The pay-back period for these modifications has been, in most instances, less than one year.

What is the federal government doing to curb automotive fuel consumption?

The average fuel economy of all Canadian cars in 1975 was about 17.5 miles a gallon. By 1980, new cars sold in Canada must average not less than 24 miles per gallon of fuel and, by 1985, not less

than 33 miles per gallon of fuel under the government's new car mileage standards.

This will result in a lower level of total gasoline consumption in 1985 than in 1975, even if the number of autos grows at 3 per cent a year.

The government excise tax program has established an additional tax of 10 cents on motor gasoline at the pump, another on air conditioners used in cars and has introduced a graduated automobile sales tax based on vehicle weight.

What is the role of the car buyer in conservation?

Automobiles consume about 15 per cent of our total energy budget and about 25 per cent of our oil so they are a prime target for the federal government's energy conservation program. The consumer can help save on his energy bill by buying smaller and lighter cars and by avoiding frills like air conditioning.

The stickers that appear on all new model cars indicating promised gas mileage and the new car mileage listing available from Transport Canada in 1977 will help the consumer choose the energy-efficient car most suited to his needs.

How can one save on car maintenance and operation?

If you are driving, save by not topping the tank to overflowing when you fill it up; by slow stopping and starting, and driving at constant speeds to keep the engine working at maximum efficiency; by avoiding long warm-ups and idling, by selecting the proper fuel and oil; by using the highest gear suitable for the situation; and by not exceeding the posted speed limits (cars driven at 55 mph instead of 70 use 20 per cent less fuel).

Have a regular engine tune-up. Spark plug misfiring 10 per cent of the time causes an 8 per cent rise in fuel consumption and a good air filter is important to efficient fuel use. Also important are the manifold heat control valves and choke efficiency. Proper tire pressure and a good alignment prevent unnecessary drag on the engine.

Also, consider such alternatives to driving your own car as car pooling, and, where appropriate, walking, bicycling or taking the bus. Combine short trips into one long one to allow engine to warm-up in winter.

A block heater, but with timer added to be sure the heater is on no longer than 2 or 3 hours prior to start-up, allows the engine to heat up faster. Cold motors use up to 30 per cent more fuel than warmed-up ones.

What about the federal government's own energy use?

A program called "Save 10" is designed to reduce government energy consumption by 10 per cent from spring of 1976 to early 1977 — and energy use is to be held at that level for the coming 10 years. The first year of the program will save the taxpayer at least $25 million.

Industry can benefit by studying the program, which includes improvements in administration and equipment operation and a blitz directed at the employee to encourage him to do his part in saving energy. All federally funded programs will follow the energy conservation guidelines.

What about industry?

The government is encouraging greater energy efficiency in industry and small business. The booklets "First Steps to Energy Conservation for Business" is available free from Office of Energy Conservation, and a further series of conservation handbooks will be published.

Fast write-off provisions have been extended to include certain electric power and/or steam generating equipment used by manufacturers, and federal sales tax has been removed from a few items such as heat reclamation, heating system control and solar devices.

The government has also sponsored the formation of voluntary energy conservation task forces covering 11 major sectors of industry, and accounting for about 70 per cent of industrial energy consumed. The task forces have set targets for reductions in energy consumed per unit of output by 1980, as follows:

	Percentage Reductions
Machinery	15
Pulp and Paper	12
Textiles	11
Food Products	20
Transportation	15
Ferrous Metals	3
Non-Ferrous Metals	6
Industrial Minerals	10
Chemicals	17
Electrical and Electronics	10
Refining	(Program underway)

ELECTRICITY

How much electricity does Canada use?

Over the past 25 years, Canadians have been increasing their electricity use by 6.6 per cent each year, on average. In 1975, the total demand dropped slightly because of the economic slump, but, in 1976, demand was again on the rise, partly due to increased use of electricity in homes.

Generally speaking, 42 per cent of our electricity (some of it produced by the industries themselves) goes to industry, 26 per cent to homes and farms, 31 per cent to commercial uses and 1 per cent to street lighting.

How much do we pay for electricity?

The prices Canadians pay are established locally, not by the federal government. Residential customers pay in cents per kilowatt hour (kWh) which is equal to one kilowatt supplied for one hour. That's the amount of electricity a 100-watt lightbulb would consume in 10 hours, or a 40-watt bulb in 25 hours.

Between 1960 and 1973, the average residential price for electricity was about 1.6 cents per kWh. Commercial rates were similar but industrial rates, which reflect the lower cost of large supplies, averaged about .8 cents per kilowatt hour.

Now, utilities selling electricity are revising their prices. The increases in 1976-77 vary across Canada from 10 per cent to over 60 per cent depending on regional costs and adequacy of previous rate changes.

Prices vary from region to region. For instance, in 1976, residential customers in Quebec using 500 kilowatt hours monthly paid 2.1 cents per kWh (about $10.50 a month). Their counterparts in Prince Edward Island paid 5.7 cents per kWh ($28.50 a month). It costs more to generate electricity in P.E.I.'s system, which depends on high-priced fuel oil than in Quebec's, which relies on hydro power.

Why will the price of electricity continue to rise?

Charges for electricity reflect the costs of supplying it, plus appropriate allowances for new additions to the electrical systems.

Between now and 1990, an enormous investment will be required. If our electrical demand grows at 7 per cent per year — the maximum projected

in 1976 — then as much as $130 billion could be spent over the coming 15 years. At a 5.5 per cent rate of annual growth, the requirement could be $40 billion less.

In addition, most of our existing generating facilities were built when capital costs and interest rates were far below today's levels, and, many of the more favorable (lowest costing) hydro sites have already been developed so that only higher cost options remain.

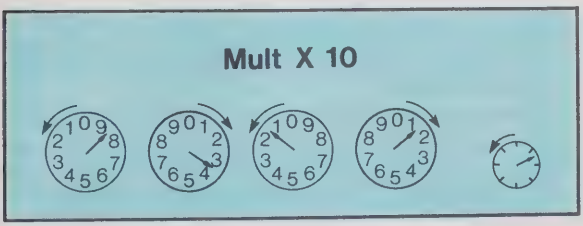
All of the added costs, including rising oil prices, must end up with the consumer in the form of price increases.

How does the consumer tell how much electricity his home is using?

To find out how many kilowatts you use during a 24-hour period, read your meter at the same time on two consecutive days. Your meter has four dials. Two move clockwise and two counter-clockwise. To get your number, read the dials from left to right and write down the smallest number the pointer has just passed on each dial and add a 0. If the pointer is directly on a number, record the next lowest number unless the pointer on the dial at its right has just passed 0. In that case, record the exact number indicated. The meter below shows the number 83110.

By keeping track of your kilowatt use you can determine what effect your efforts towards electrical energy conservation are having and which methods are most effective for you. The average energy requirement is about 33 kilowatt hours a day.

If electricity is the source of space heating and water heating in your home, these two uses are likely to account for a large share of your electrical consumption.



Is there any way the electricity supplier can cut down on costs?

Yes. The electrical utility incurs most of its additional costs in two ways: it must provide more

electricity during peak demand periods and it must bear the cost of additions to the electrical system. It can cut both kinds of cost by changing present billing methods.

Demand for electricity is highest during peak demand periods — between 4 and 7 p.m. in many areas. The supply system has to be adequate to meet maximum demand, plus a reserve margin to meet emergencies. (Severe emergencies can reduce generating ability to the point where brownouts, or blackouts, occur.)

Peak demand costs can be reduced if certain electricity-consuming activities, such as water heating and some industrial and commercial processes, are closed down during those times of day or periods of the year when the energy demands are highest. An increase in charges for energy used during peak periods would encourage customers to reduce electricity use at these times. To compensate for the cost or inconvenience, these customers would be given lower than average rates during off peak periods. The electrical utility could cut down its expenses for additions to the electrical system by charging the cost to customers who made such additions necessary by increasing their demands. A lowered rate would be available to those customers who reduced their demand.

In this way, every new customer, or an existing customer, increasing his electricity requirements, could be charged more to accommodate the additional energy and operational expenses incurred by the electric utility to fill his needs. Under present billing procedures this is not the case.

Electrical suppliers charge the same price for all customers, new and old, who consume the same amounts of power by averaging. At least two major Canadian suppliers are studying the two above forms of marginal pricing in an effort to cut their costs.

What can be done to encourage electrical energy conservation?

Both the electricity supplier and the consumer have a part to play in conservation. Pricing systems are the natural way for the supplier to control use of electricity. The more demand on the system, the greater the supply required and consequently the higher the prices. Higher prices will encourage the consumer to cut back on his electrical consumption if the benefit of using electricity does not justify the cost to him.

By comparing meter readings, the home-owner can tell where he can best save on his electricity bill.

The supplier can help by introducing individual rather than bulk metering where possible. Bulk metering is an arrangement sometimes used in apartment buildings where only the total electricity is metered. Individual tenants pay for this in their rent, but not in proportion to their individual consumption.

Good insulation saves on bills for houses heated by electricity. By exercising selective buying, the consumer can decide which of the wide selection of electrically-operated household appliances on the market are absolutely necessary and the most energy saving. Labels, soon to appear on major household appliances to indicate the machine's energy consumption, will help the consumer make the best buy.

Proper use of electrical equipment, selection of efficient lighting, efforts to conserve energy in preparation of meals, lower hot water temperatures and more effective use of hot water are other tricks that will save on electricity. A timer for the block heater in the car can also help reduce electrical costs.

What sources are used for electrical generation?

Electricity can be produced from almost any energy source. In 1976, hydro produced 72.6 per cent of Canada's electricity.

In a hydroelectric plant, the force of water turns turbines to generate electricity. The other way is to use steam to turn the turbines. This can be done by burning coal, oil or uranium. Each is a source of power for thermal generating plants.

In 1976, conventional thermal sources supplied 21.8 per cent of our electricity and thermal nuclear plants 5.6 per cent. By comparison, in 1960, 93 per cent of our electricity came from hydro plants and only 7 per cent from conventional thermal plants.

Will these sources change in the near future?

Yes. Our most economical hydro sites are now developed and the price of fossil fuels is going up.

By 1990, hydro generation could be contributing as little as 53 per cent of Canada's electricity — well down from today's 72 per cent. Coal is likely to become more important in conventional thermal plants. Substantial growth in nuclear power generation may also occur.

Canada has large coal deposits and our uranium prospects are good. Conversion to electricity is

a proven method of making these energy sources available to consumers.

Further in the future, more power may be generated as a byproduct of industrial processes, from ocean tides, solar and wind power and from geothermal energy (heat from the earth).

How does Canada's use of electrical energy sources vary from region to region and could there be greater sharing between provinces?

Hydro produced almost all Quebec's electricity in 1975 and provided the lion's share of power in Newfoundland, Manitoba, British Columbia and the Yukon. Ontario is now heavily dependent on coal imported from the United States, but hydro and nuclear power are also important.

In Alberta and Saskatchewan coal mined in the province is a major source. The Maritimes are heavily dependent on imported oil. Ontario, Quebec and New Brunswick are turning more to thermal nuclear plants.

The federal government is encouraging more sharing of electrical capacity. When neighbouring electrical systems are connected, one utility can help another if one of them suffers power shortage or interruption. Surplus lower-cost energy can be moved between systems to minimize use of high cost generation.

Interconnection may also allow construction of larger generator units to increase electrical output at lower costs.

How much electricity do we export?

In 1976, Canada's net export of electricity to the United States was 9, 287,851 mWh — 3.2 per cent of our total generation. Net exports are determined by subtracting our imports (3,513,033 mWh in 1976) from our total exports (12,800,884 mWh).

NUCLEAR POWER

Where are Canada's nuclear power plants located? Has the federal government been a participant in development of these plants?

As of 1976, nuclear generating stations were in operation at three Ontario sites — Pickering, Tiverton and Rolphton, and at Gentilly, near Trois-Rivières, in Quebec.

Federal agencies work closely with provincial electrical supply utilities in planning nuclear plants. The first nuclear plant located in any province may receive federal financial backing to the extent of 50 per cent of the cost. During 1976-77, the federal government budgeted $118 million for loans to Hydro-Quebec and the New Brunswick Electric Power Commission. The loan to Quebec is in support of the 600 mWe Gentilly II reactor which will begin to operate in 1979. New Brunswick's first nuclear plant, at Point Lepreau is scheduled to begin operating in 1980.

How does the CANDU reactor actually operate?

The aim of water-cooled power reactors is to create heat which can convert water to steam to turn turbines to produce electricity.

The basic material from which the heat is generated in a CANDU reactor is in the form of pellets of uranium oxide fuel in zirconium-alloy metal tubes which are combined into bundles. The actual reaction takes place within pressure tubes which are part of a large tank containing what is known as heavy water. Once the fuel bundles have been inserted into the pressure tubes, and the fission, or splitting apart, of the uranium fuel atoms has begun, the heavy water helps keep the reaction going properly.

As it is produced, heat is transported by pressurized heavy water from the fuel to the boilers where steam is generated to turn the turbines.

In foreign reactors which use enriched fuel, ordinary water or other substances may be used instead of heavy water. The heavy water is costly to produce, but once in operation, CANDU uses uranium more efficiently in the production of power. The CANDU system has the advantage of using natural uranium rather than enriched uranium as a fuel.

What type of serious problem could occur in a CANDU reactor?

A reactor breakdown could NOT result in an explosion similar to that of an atomic bomb.

Normally, heat is carried away from the reactor by fluids as it is produced. As the nuclear fuel is burned, it produces fission products — radioactive material some of which is in gaseous form. In normal conditions, these materials are confined within the immediate area of the reaction. Should there be any minor leakage into the cooling fluid, the fission products are confined within the coolant circuit.

An accident might conceivably cause a loss of the cooling fluid and, if preventive measures did not come into effect, this could result in a build-up of heat.

This build-up, if not checked, could ultimately result in a release of the radioactive fission products outside the primary coolant circuit. The reactor is designed so that almost all of the radioactivity released would be retained within the reactor containment structure. Only a minor part of these products might be carried in the air beyond the protected area around the reactor site.

To prevent any such chain of events, not one but a series of emergency control systems are built into the reactor. Out-of-the-ordinary occurrences in the plant will trigger a mechanism to stop the nuclear reaction. In addition there are several back-up systems capable of initiating an independent shut-down.

Additional devices are available to deal with a serious break in a pipe resulting in a loss of coolant. Even after an emergency halt to the nuclear reaction, heat would be generated by the fission products, so a continuous supply of coolant would be necessary. The lost fluid would be replaced by water injected into the reactor core. Again, this emergency action could be triggered by any one of several available mechanisms.

Over many years of operation, these safety systems have been (and will continue to be) thoroughly analyzed and continuously refined. This watchfulness is one of the reasons why Canadian power reactors have been able to operate without the kind of major accident described above.

√ **Who is responsible for the safe operation of reactors and other safety aspects?**

Electricity-producing reactors are operated by the agencies which supply power to customers in various provinces, under very strict supervision by a federal agency, the Atomic Energy Control Board. The Board has a broad responsibility for safety and security in virtually all matters involving radioactive material and substances, such as uranium, which are capable of releasing atomic energy by nuclear fission.

Any potential user of such substances must apply for permission from the Board, and supply details of why, how, and where they are to be used. The Board must be satisfied as to precautions against theft, loss or unauthorized use, and very close attention is paid to limiting — and checking on — exposure of individuals to radiation which could have health effects, and controlling any radio-

active discharge to the environment according to international standards.

Training of operating staff has to meet AECB standards, as do arrangements to compensate for injuries or damages resulting from operations of a plant involved in fuel preparation or an actual reactor.

Several stages of licencing are required before a nuclear power reactor can go into operation, including studies of the appropriateness of a proposed site, review of the safety features of the design before issuance of a construction permit, and a close assessment of readiness to operate prior to board approval of a conditional operating licence.

Operations are monitored by board inspectors and, in addition, reactors are subject to inspection by the International Atomic Energy Agency as provided by the Treaty on the Non-proliferation of Nuclear Weapons.

A guiding principal of nuclear power development has been to be even more cautious than international bodies setting standards for exposure to radiation and for protection of nuclear materials against misuse. Even so, the tightening of Canadian standards and protective measures continues, with the objective of assuring that risks from nuclear power are extremely low — much lower than the risk from automobile accidents and generally lower than the risk from hazardous chemical substances widely used by industry.

Public discussion of nuclear power has increased. How are government agencies involved in this?

The federal government, through a Crown corporation, Atomic Energy of Canada Limited, has fostered CANDU development. Attempts to expand awareness of our nuclear program — and to examine all aspects of safety and security — are encouraged by the federal government. The Atomic Energy Control Board is always ready to review its procedures and undertake improvements if necessary.

A very thorough review is being made by the Ontario Royal Commission on Electric Power Planning. It is examining, among others, the following questions:

Are plans to cope with a major nuclear accident adequate and is the general public near nuclear plants aware of the details?

Is adherence to internationally-established standards for exposure to radiation adequate to protect public and workers, particularly uranium miners?

Can the public be sure that exposure to radiation from nuclear power plants is within the strict limits established by the AECB?

What is being done, or planned, to assure safe and secure handling of radioactive wastes, and how significantly will storage expenses add to costs of generating electricity?

What will be involved in decommissioning nuclear power plants?

What are the advantages and disadvantages of alternate methods of waste heat disposal? How much addition of heat to the Great Lakes, through discharges from nuclear (and other thermal) plants, is acceptable?

Since nuclear plant construction requires heavy investment, is it likely there would be problems raising capital for major expansion of nuclear power?

How adequately could electric power demand be met without such an expansion?

How important, financially, is the fact that the cost of nuclear fuel is at present lower than the cost of coal?

Will it eventually be necessary to extract plutonium from reactor wastes to assure adequate reactor fuel supplies?

NOTE:
Many of these questions have been considered in detail in other publications. Information on these publications is available on request from:

Information EMR, Department of Energy, Mines and Resources, 588 Booth St., Ottawa, Ontario, K1A 0E4

What measures has the federal government taken to ensure that members of the public are compensated for any injury or damage to property that might result in the event of a nuclear accident?

In the fall of 1976 the government proclaimed the Nuclear Liability Act which requires operators of nuclear power stations to carry $75 million of liability insurance to compensate claimants, without proof of fault, for any losses caused by accidents involving radioactive or fissionable materials. The same Act provides for the establishment of a Nuclear Damage Claims Commission to assess compensation and pay claims if damage should exceed $75 million.

What has been done to ensure that Canada has a secure supply of uranium?

In 1974, the federal government announced a policy to protect our supply of uranium. Under the

terms of the policy, firm export deliveries are permitted only for a 10-year forward period. The policy allows the conditional approval of exports for another five years, and provided that Canadian utilities can recall the material when they can't obtain it in any other way.

The second main feature of the policy is a protection formula for domestic utilities. Sufficient uranium must be reserved to enable each nuclear reactor, operating or planned within the next 10 years, to be run for 30 years at 80 per cent capacity. Canadian utilities are also required to negotiate contracts to ensure that they have enough uranium 15 years ahead of time to fuel both operating and committed reactors.

What has been done to ensure that Canada retains ownership of her uranium resources?

In 1970, the federal government announced its uranium ownership policy which limits foreign ownership of our uranium industry to 33 per cent at the mining stage. The policy doesn't limit foreign participation in exploration and many foreign companies are taking part in joint ventures or exploring on their own. Foreign companies can protect their investment by stipulating at the beginning of an exploration venture the terms governing the surrender of their share to a Canadian partner if it becomes necessary to do so.

How do Canadian uranium resources compare with those of other countries? How much uranium is being produced, and what is the export picture?

As of mid-1976, Canada estimated its reasonably assured resources of uranium at up to 225,000 short tons — if the world price for uranium oxide (U_3O_8 — the marketed commodity) is up to $40 a pound. This was about 10 per cent of the world's total uranium resources of the same category.

The largest uranium producer in 1975 was the United States followed by Canada and then South Africa. Canada produced 6,200 short tons in 1976. As of mid-1976, total export commitments were 100,000 short tons. Major markets are Japan, Britain, West Germany, Spain and, beginning in 1977, the United States.

COAL

We hear Canada has a great deal of coal. Why isn't it being used to replace oil and gas to supply our energy needs?

Canada has abundant coal resources. The trend towards coal's use as a replacement for oil and gas has already started, and will increase greatly in the future. To determine as closely as possible how much coal Canada has and how much can be developed, the federal government, with co-operation from the provinces, is preparing a national coal inventory.

To what extent can Canada use coal instead of oil and gas?

In 1976, coal production in this country totalled about 29.5 million tons. This is expected to jump to almost 40 million tons by 1980, and could reach about 70 million tons by 1985. Part of this increased production will be exported for steel making, but most of it will be used in Canada, in many cases to replace oil and gas.

Does this mean that by 1985 Canadians will be shovelling coal to keep their houses warm?

No, that's not likely to happen. But it is possible that many homes, especially in housing developments, will be heated by steam or electricity generated at a central coal-fired plant.

The greatest potential for increased use of coal is for thermal generation of electricity. Some thermal power plants today burn oil; in future, the emphasis will be on building coal-burning plants. Some conversion of existing oil-fired plants, to enable them to burn coal, is probable.

Also, federal researches are investigating new technologies, including a method of burning oil and pulverized coal together. If successful, the system could reduce oil consumption in power plants by up to 30 per cent. This would be a boon to areas such as Nova Scotia which are highly dependent on oil for power generation.

In addition, many manufacturing processes require high temperature steam; in these industries, studies will be conducted to determine where conversion to coal is possible and practical.

Are there other uses for coal?

Yes — almost one-third of the coal consumed in Canada each year is used to make coke for the

steelmaking industry. But there are also possibilities for increasing coal's energy role. Federal and provincial experts are studying the potential for manufacturing gas from coal.

Alberta's large reserves include extensive deposits of low-grade coal currently uneconomic to produce and transport to the large eastern market. Perhaps gasification plants could be built near the coalfields, or the coal gasified underground, and the manufactured gas moved by pipeline.

Also, the possibility of using coal in place of petroleum in the petrochemical industry is being examined. Any success in this direction would free more petroleum for other uses.

How much coal does Canada sell to other countries?

In 1975, Canada exported 12.9 million tons of coal. Two-thirds of this coal was shipped from British Columbia, and most of the rest from Alberta. More than 90 per cent went to Japan, for that country's steel industry.

In the same year, Canada imported 16.8 million tons of coal, almost all of it moving from the eastern United States to Ontario. Half of this coal was used for thermal power generation, and the other half by Ontario's steel industry.

Are there any special problems connected with greater use of coal?

Yes, there are several problems. Right now, the biggest is transportation. About 95 per cent of Canada's coal occurs in Alberta and British Columbia, but one of the main domestic markets for this coal is in central Canada. Moving the coal east has, up to now, been restricted and expensive. Over the next few years, however, conditions for moving coal from western Canada will be improved. Rail lines are being upgraded, and special train systems are being built to carry western coal to Thunder Bay. There, at a new terminal to open in 1978, the coal will be unloaded and transferred on a massive scale to special lake ships to serve southern Ontario.

What about the effect of coal mining on the environment?

Most western coal is mined from the surface. To prevent large-scale disturbance, most coal-mining provinces have regulations that require mining

companies to restore the land as mining progresses. Because of widespread public concern about open-pit mining, the coal industry is conscientious in abiding by these regulations.

Steps are also being taken to reduce air pollution when coal is burned, to conform with present and planned strict air pollution laws. The main pollutants are sulphur dioxide and particulate matter. Fortunately, most western Canadian coal is low in sulphur content.

RENEWABLE ENERGY

What are renewable energy resources?

Renewable energy resources include energy available from the sun either as direct solar radiation or embodied in winds, waves, rivers, temperature gradients, plants and animals; from the earth's internal heat as geothermal energy; and from the earth-moon system as tidal energy.

All are renewable in that they do not depend on an energy source which is depletable within the time frame of man's existence.

Many are scattered and only available intermittently in useful amounts, depending on factors such as season, weather, local site characteristics, and the nature of the work to be done.

Most have been harnessed by man in the past with simple technologies, but modern engineering methods promise to improve their efficiencies and range of applications.

What is the most important renewable energy resource currently used in Canada?

Rivers harnessed to produce electricity supplied approximately 75 per cent of Canada's total electrical energy production in 1975, or nearly 25 per cent of Canada's primary energy consumption. Substantial additions to hydroelectric capacity are projected and hydro is likely to remain, for several decades at least, the most significant renewable energy resource in Canada.

Hydroelectricity may also be generated by building special barriers across a tidal basin with a high tidal range, and using the ebb and flow of waters to power turbines. A recent federal-provincial feasibility study has indicated that electrical power from the 53-foot tidal range of the Bay of Fundy will remain uneconomical at least for another

decade. But longer term research is continuing to assess the environmental and engineering issues involved in such a project.

Small- scale water power or hydroelectric dams may have an important future in Canada, particularly for meeting demands in remote areas.

What are the possibilities of using solar energy in Canada?

Solar radiation may be converted directly to electricity in crystal cells; or collected, stored and used as heat. Technologies for direct electrical conversion await major improvements in efficiencies and reductions in costs before they are used on a larger scale than specialized remote site applications.

The majority of Canadians live in areas with sufficient exposure to solar energy and a high enough heating demand to justify the application of solar energy to meet at least part, if not all, of their space and water heating requirements in residential and commercial buildings. A very well insulated structure is needed for all economic solar space heating, and good building design and community planning are also important.

How does solar heating work?

In general, solar heating systems are made up of a number of glazed solar collectors oriented to take advantage of available radiation; an insulated heat storage mass of rocks, salts, or water, usually located in the basement; pumps, pipes and thermostatic controls; and a heat distribution system using either forced air or water to heat the living space. Solar energy collected on the black-painted surfaces is transferred as heat to an air, water, or anti-freeze solution and carried to storage.

Heat pumps may improve system efficiencies in both solar and conventional electrically heated homes. In cases where solar energy provides only part of the heating load, back-up conventional heating hardware is required.

What are some of the difficulties with solar energy?

Currently, the high capital cost to consumers, associated primarily with seasonal thermal storage, is the major bottleneck to widespread use of solar space heating. The objective of the new federal solar energy research and development

program is to develop and demonstrate reliable and cost-effective solar space heating under Canadian climatic conditions.

A range of systems is being assessed across Canada, including total and partial heating in single- and multiple-family housing and commercial buildings. Testing procedures, product quality standards and laws for the protection of the consumers have yet to be developed.

Other aspects being studied include the use of conventional energy supply systems as back-up support, financing, industrial development, and public acceptance. These issues all affect the widespread adoption of solar space heating in Canada.

How effective is the windmill as an energy producer?

Wind energy is "high grade" since shaft power can be readily and efficiently converted to electricity. However, its diffuse nature requires that the windmill, or array of windmills, be large in order to get useful amounts of energy, and its intermittent supply requires that a storage system, such as batteries or pumped water, be available if the wind is to be the exclusive power source.

The size of apparatus and storage requirement result in high capital costs. The principal concern of the wind research and development program of the National Research Council of Canada is to develop technologies which reduce these costs while remaining reliable for long times with minimal maintenance.

The horizontal-axis ("propeller") windmill has long been familiar. Another approach is the vertical-axis ("egg-beater") type mill. Propeller-type mills can operate at higher efficiencies over a wider range of wind speeds because of their continuously adjustable blade pitch, though a spoiler arrangement must be built in to prevent overloading of the generator or blade failure at high windspeeds.

Vertical-axis mills, such as those being developed by the National Research Council of Canada, are designed for peak efficiency at one windspeed, above which efficiency declines. This protects against overload. The disadvantage of lower power output may be offset by designing the vertical-axis mill for peak efficiency coinciding with the average windspeeds expected at the site. This requires the development of a data base for selected sites across Canada on windspeeds at heights suitable for windmills.

Where might windmills be put to use?

Areas in Canada with suitable windspeeds (usually above 16 km/hr) appear to be the Maritimes coasts, the extreme southern Prairies, the Arctic and Hudson Bay lowlands, and certain valley sites in the western Cordillera which exhibit natural wind-tunnel effects.

Large vertical-axis windmills currently appear to have lower capital cost per kw than horizontal-axis mills of comparable size. Nevertheless, the National Research Council of Canada and Hydro-Quebec's new prototype vertical-axis mill on the Magdalen Islands will have a capital cost per kw of about $1,400 compared with $700/kw currently quoted for CANDU nuclear reactors — a power generating system still regarded as being capital-intensive.

However, for locations such as the Magdalen Islands and other remote or northern Canadian communities, windmills may have capital costs competitive with existing diesel-electric systems, and these costs could be offset over the system lifetime by the savings made in imported diesel fuel.

Windmills might also be hooked into conventional electric grids, with the user either drawing power directly from the grid, or from the windmill, and feeding surplus mill-generated electricity into the grid.

What is biomass energy?

Biomass energy is the energy stored in plant and animal matter. It may be obtained by biological or chemical conversion, or by direct combustion. Agriculture and forestry crops, and organic wastes have potential energy value primarily as combustible solid, gaseous, or liquid fuel sources, and indirectly as substitutes for high energy cost items such as fertilizers.

In biological conversion, methane (essentially natural gas) is produced by the action of bacteria digesting organic material, such as sewage or manure slurries, in the absence of oxygen. The Biomass Energy Institute (Winnipeg), the University of Manitoba, and the National Research Council of Canada are the major Canadian developers of biogas digestors for use in farmyards and the food processing industry. Research programs are currently seeking improvements in system reliability, costs, and energy efficiency.

In what ways can wood be used to produce energy?

Canada's large forest resources have considerable potential as an energy source to reduce dependence on imported oil. The federal government has launched studies on the costs, technologies, and potential of using Canadian surplus timber resources to produce liquid fuel substitutes for transportation purposes. Methanol or ethanol may be obtained by fermentation or pyrolysis of wood and may be used in blends with conventional gasolines with minor engine modifications.

The pulp and paper industry has increasingly used wood and wood wastes for generation of electricity, and is investigating gas and chemical feedstock production from wood. The Province of Prince Edward Island, in partnership with the federal government is studying the use of local woodlots to fuel a thermal-electric power plant. Several cities burn municipal garbage with high paper and plastics content for district and industrial heating.

Wood stoves and wood-burning furnaces are now much more efficient for space heating. New designs can burn for 12 hours per load, take logs up to three feet long, and have draft controls to accurately balance room temperatures. Combination wood-oil burners allow oil to cut in if the wood fire dies out. These modern stoves may be as much as 10 times as efficient as ordinary fireplaces.

Does Canada have useful geothermal energy resources?

Little is known about Canada's potential for using geothermal energy — energy based on the earth's internal heat. The geophysical nature of the western Cordillera makes parts of the area suitable for geothermally heated waters (at temperatures of 80°-250°C). Similar resources may also be found in the deep sedimentary basins of the Great Plains and the Western Arctic.

Though there is little current industrial interest, the Earth Physics Branch of EMR and some provincial utilities, notably BC Hydro, are exploring the potential of geothermal energy for a wide variety of possible uses. The geothermal site at Meager Creek, B.C., may provide electrical power to Vancouver in the future.

Problems include remoteness of some of the best sites from main centres, and the disposal of brines which may include noxious materials. It will likely be a long time before deep wells for tapping the heat of the earth's crust in quantity become enonomically competitive.

How much did the federal government spend on energy research and development in 1976?

The table below shows how federal R&D funds have been distributed. Current planning will provide an increased share for renewable energy forms in the near future.

	1976-77	1975-76
Nuclear	$ 93.7 million*	85.3
Fossil fuels (oil, gas and coal)	14.0	9.2
Conservation	9.1	5.9
Renewables (hydro and tidal, solar, wind, geothermal and biomass)	4.7	2.9
Transportation and transmission	6.1	6.8
Coordination	0.2	—
Total	$127.8 million	110.1

*Of this amount 83.4 will be expended by Atomic Energy of Canada Limited in the following manner:

Power reactor systems	29.7
Nuclear fuel cycle	15.9
Environmental protection and radioactive waste management	7.4
Heavy water processes	8.4
Underlying and advanced systems research (some medical research work included in this item)	22.0